



## PATENT SPECIFICATION

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## COMPLETE SPECIFICATION

## Improvements in Elastic Fluid Power Plants

We, AKTIEBOLAGET LJUNGSTRÖMS ÅNGTURBIN, a Corporation organised under the Laws of the Kingdom of Sweden, of 32, Kungsgatan, Stockholm, Sweden, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

- 10 This invention relates to power plants operating with an elastic fluid as working medium and subjected to variable loads at varying speeds, and more particularly to such power plants of the type comprising a feeder section containing one or more compressors and their driving engines, a power motor section producing a useful output, and heating means such as one or more combustion chambers for heating elastic fluid compressed by the compressors of the feeder section so as to convert said medium into motive fluid for operating the compressor motors of the feeder section and the motors of the power section.

- 25 Power plants of this type are utilised for traction purposes, as, for example, for the propulsion of road and rail vehicles, for the operation of oil well drilling and logging rigs, of power shovels and the like. For the sake of convenience, the motors of the power section will be hereinafter termed "power motors".

- 35 The primary object of the invention is to provide a power plant or system having its component parts arranged in a novel relationship resulting in a new cycle of operation capable not only of highly efficient thermodynamic performance but also inherently productive of the characteristic required to handle traction loads demanding the production of high values of torque at stall or slow speed with decreasing torque demand as speed increases, while at the same time calling for the application of maximum

power or tractive effort to the load irrespective of speed.

A further object of the invention is to produce a suitable cooling of the working surfaces of the motors in contact with the working medium operative in such a way that the motors are sufficiently cooled even at low speed or at stall, since they are exposed to the hot working medium even under such working conditions.

According to the present invention, in a power plant of the type referred to above all motors of the power section are of the positive displacement type, and conduits conveying working medium to the driving engines of the feeder section and to the power motors are in open communication with one another, so that with decreasing speed of the motors of the power section the resultant diminished flow of working medium through said section produces an increased supply of working medium to the driving engines of the feeder section resulting in increased pressure of the working medium and thereby increasing the torque developed by the power section.

By the term "motor of the positive displacement type" used throughout this specification and claims is to be understood an engine of the rotary screw wheel type having at least two rotors rotatably mounted in a housing each formed with helical lands and grooves disposed in intermeshing relation and which engine, due to expansion of an elastic fluid in the working chambers formed between the lands and grooves and the surrounding housing, operates as a motor.

Decreasing speed of the power section, consisting of one or more motors, from a constant level of operations results in a diminished flow of motive fluid through the power section, until at stall no motive fluid passes through the power section, apart from leakage. This change in operation results in an increased quantity

of the motive fluid to the motors of the feeder section, and, consequently, in an automatic increase of the pressure of the motive fluid in the system. An increased  
 5 pressure thus acts upon the working surfaces of the power motor, thereby giving an increased torque to the external load. In other words, the power motor in the system shows a torque characteristic that  
 10 has its maximum at stall and falls with increasing speed of the motor.

The invention will be hereinafter described more in detail with reference to the accompanying drawings, illustrating  
 15 by way of example certain embodiments thereof, and in which:—

Fig. 1 shows, partly in section, one embodiment of the system of the invention where not only the power motor, but  
 20 also the compressor and the compressor driving engine, consist of positive displacement machines.

Fig. 2 is a section of the compressor along the line II—II, and Fig. 3 a section of the power motor along line  
 25 III—III, both of Fig. 1.

Fig. 4 shows on a smaller scale an embodiment similar to that of Fig. 1, but having the driving engine of the compressor in the form of a turbine and the  
 30 combustion chamber divided into two parts, one part for the power motor and the other for the compressor turbine.

The plant shown in Fig. 1 comprises as  
 35 its main parts a compressor 10 for compression of the gaseous working medium, a driving engine 12, connected to said compressor, a power motor 14 for producing useful power developed by the  
 40 plant, and a combustion chamber 16 where the necessary working medium is produced by combustion of a suitable fuel, generally liquid or gaseous, in the  
 45 gaseous working medium compressed by the compressor, this medium, as a rule, being air. A number of pipes or ducts, necessary for the distribution of air and gas, complete the system.

Air is sucked into the compressor 10  
 50 through an air intake 18, compressed between the lobes of the rotors 20 and 22 and the compressor casing 24, and leaves the compressor through its outlet 26 open into a distributing chamber 28 directly  
 55 communicating with the exhaust end of the compressor casing. From this distributing chamber 28 part of the compressed air is conducted through the cooling system of the compressor motor 12, directly connected to said chamber 28,  
 60 and then to the combustion chamber 16 through conduit 30. The rest of the air is led through conduit 32 into a distributing chamber 34 at one of the ends of  
 65 the power plant 14, whence it passes

through said power motor and through conduit 36 also into combustion chamber 16.

In combustion chamber 16 a suitable quantity of fuel, for instance, oil, is injected through the nozzles 38 and is  
 70 burnt, after which the hot working medium thus produced is conducted in part to the compressor motor 12 and in part to the power motor 14 through the  
 75 conduits 40, 42, respectively. When the gas expands between the rotors 44 and 46 and the casing of power motor 14, the thermal energy of the gas is converted into mechanical energy, which is utilised  
 80 through an output shaft 50.

The compressor motor in the illustrated embodiment being of the same design as the power motor, the energy, in this case,  
 85 is also converted in the manner described with reference to the power motor and the power developed by the compressor motor is transmitted to the compressor through a shaft 52 and coupling 54. In the illustrated system the shaft between  
 90 the two machines is connected to the rotors 20 and 56.

The expanded gas leaves the power motor through the exhaust 58 and the compressor motor through exhaust 60,  
 95 and may escape either directly into the atmosphere or may first pass through a regenerator (not shown) and there transfer part of its heat content to the compressed air, before the latter is led to the  
 100 combustion chamber 16. As already mentioned above, the compressed air, on its passage to the combustion chamber 16, passes through the cooling system of the motors 12 and 14. As indicated in the  
 105 figure, one of the functions of the air is to cool the rotors and the casing in the respective motors. For this purpose, the air is distributed from the respective distribution chambers 28 and 34 to the cooling  
 110 systems of the rotors and the casing, and is supplied at the opposite sides of the motors to the two conduits 30 and 36, respectively. The cooling thus obtained permits a high temperature of the work-  
 115 ing medium and thus a high output per unit weight of air as well as high thermal efficiency is obtained.

A more detailed description of the compressor and the construction of the  
 120 motors regarding a suitable design of the rotors, of the inlet and outlet ports as well as of the cooling system, is set out in the specification of our co-pending  
 125 Patent Application No. 27814/47 (Serial No. 645,848). For the purpose of cooling, the rotors are provided with cooling channels 62 and 64 (Figs. 1 and 3), preferably running along the rotor lands.

It should here be pointed out that the  
 130

compressor may be of any suitable type; such as a displacement compressor or a dynamic, that is, centrifugal or axial flow compressor, and that the compressor motor 12 need not necessarily be of the displacement type, but may equally be, for instance, a gas turbine of positive or reaction type of suitable design. The power motor, however, must be of displacement type in order to produce the special operating characteristics aimed at by this invention.

The main difference between the embodiment shown in Fig. 4 and the embodiment described above is that the motor of the compressor 10 comprises a gas turbine 66 and that two combustion chambers 68 and 70 are substituted for the common combustion chamber 16 described in the preceding embodiment for the purpose of providing an adjustment of the temperature of the working medium to a temperature suitable for the respective motor according to its resistance. This system operates as follows:

Air is sucked into the compressor 10 through its inlet 18 and is compressed as previously described. The compressed air is led through conduit 72 to the power motor 14, passes through the cooling system of the power motor so as to cool its working surfaces, and is led through conduit 74, which branches into two combustion chambers 68 and 70. In these combustion chambers the compressed air is heated by the combustion of suitable liquid or gaseous fuel injected through the nozzles 76, 78, and converted into motive fluid which finally is led through conduits 80 and 82 to the compressor turbine 66 and to the power motor 14, respectively. This motive fluid expands there with transformation of its heat energy content into mechanical work and escapes through outlet 84 or 58 to the atmosphere or to a heat exchanger.

It is, of course, not essential to allow the entire quantity of compressed air to pass through the cooling system of the power motor. As an alternative, part of the air may be led directly to the combustion chambers through a branch pipe 86 indicated by dotted lines in Fig. 4. A valve 88 or the like is preferably located in the branch pipe 86 to control the amount of air flowing therethrough.

With a system arranged according to the invention, it is possible to obtain a starting torque which is 5 or 6 times the normal operating torque. If in a system as described above the power motor of the displacement type is replaced by a turbine, a maximum torque multiplication can be obtained, under otherwise similar conditions, which is only 2 to 3 times the

normal operating torque. If for any given case a torque multiplication of 2 to 3 times the normal operating torque is sufficient, this torque multiplication can be obtained, according to the system of the invention, at considerably lower costs and with higher efficiency than if the power motor comprised a turbine.

The invention is, of course, not limited to the systems described above, but may be modified in its details. For example, it is possible to use a common combustion chamber for the system described with reference to Fig. 4 and, at the same time, to lead part of the compressed air so as to mix with the heated working medium supplied to the compressor turbine in order to produce different temperatures of the motive fluid supplied to said turbine and to the more efficiently cooled displacement type power motor.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A power plant operating with an elastic fluid as working medium and subjected to variable loads at varying speeds of the type set forth in which all motors of the power section are of the positive displacement type and in which conduits conveying working medium to the driving engines of the feeder section, as hereinbefore defined, and to the power motors are in open communication with one another so that with decreasing speed of the motors of the power section the resultant diminished flow of working medium through said section produces an increased supply of working medium to the driving engines of the feeder section, resulting in increased pressure of the working medium and thereby increasing the torque developed by the power section.

2. A power plant according to Claim 1, in which the open communication between the streams of working medium flowing to the compressor driving engines and to the power motors, respectively, is effected through one or more heating means, such as combustion chambers, common to said driving engines and motors.

3. A power plant according to Claim 1, which includes separate heating means, such as combustion chambers, for the working medium supplied to the compressor driving engines and to the power section, the inlet conduits to the different combustion chambers being in open communication with each other.

4. A power plant according to any of Claims 1 to 3, in which, in addition to

the motors of the power section, the compressors and possibly also their driving engines are of the positive displacement type.

- 5 5. A power plant according to any of the preceding claims, in which at least these motors designed as displacement machines are cooled.

- 10 6. A power plant according to Claim 5, in which the displacement machines are provided with cooling systems, preferably in the form of channels immediately below the working surfaces, in contact with the hot working medium, said cooling systems forming part of the compressed fluid conduits from the compressor to the heating means so as to cool said working surfaces by means of cold elastic

fluid, whereby the cooling of the power motors will be effective even when said 20 motors run at low speed or are at stall.

7. A power plant according to Claims 1 to 3, in which the driving engines of the feeder section consist of one or more gas turbines. 25

8. A power plant operated by an elastic fluid constructed, arranged and operating substantially as described with reference to Figs. 1 to 3 or to Fig. 4 of the accompanying drawings. 30

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Fig. 1.

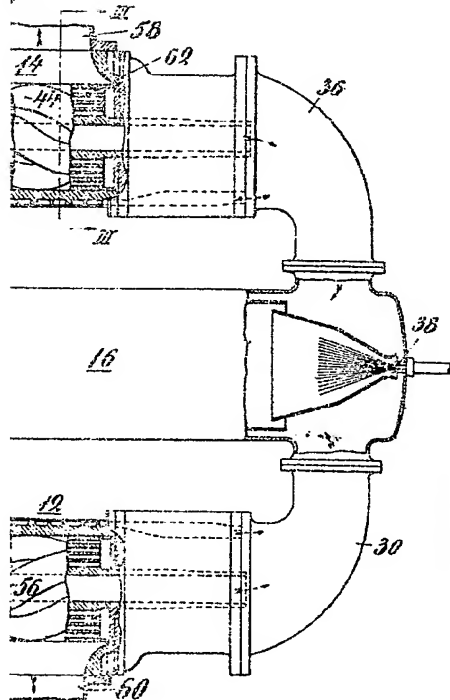
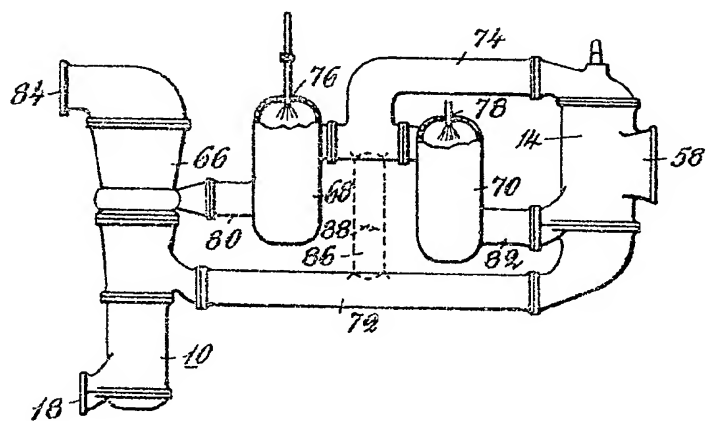


Fig. 4.

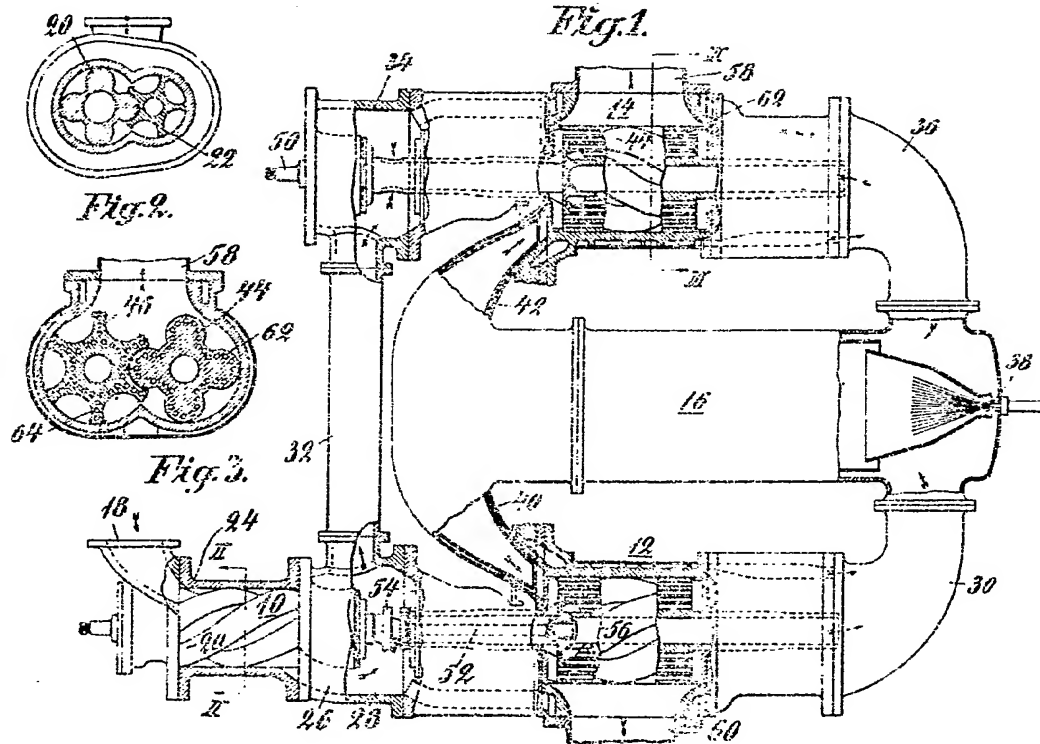


**POOR  
QUALITY**

647089 COMPLETE SPECIFICATION

SHEET 1

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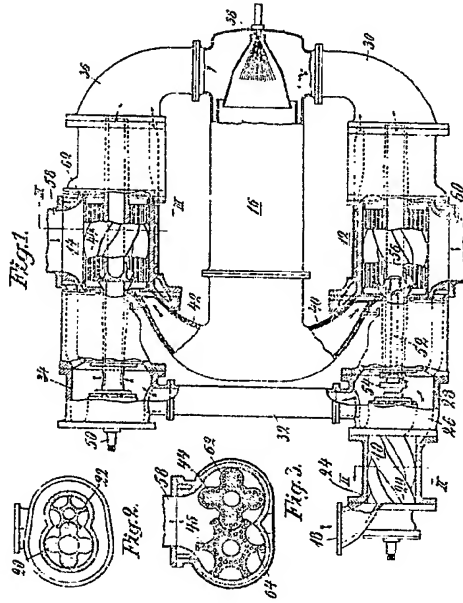


Fig. 1.

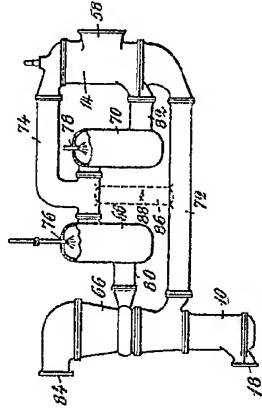


Fig. 4.